

The Perturbations of Sappho (80). By Robert Bryant, B.A., D.Sc.

The following values of the perturbations of *Sappho* form a continuation of those previously published by me. As previously, the elements have been corrected for the effect of perturbation every forty days. Great pressure of other matters has prevented me from preparing for the time of the opposition of this planet in 1889 an ephemeris such as will be required for the reduction of the observations for determining its parallax. I have partially revised my previous work on the orbit of this planet. Dr. Otto Knopf has pointed out to me errors in some of the normal places, in correcting some of which a better representation of the observations is obtained. I have also found minor mistakes in the calculation of the perturbations, which must be expected when one deals single-handed with three millions of figures; but these have no great effect upon the result. I have, however, detected an error of a more serious kind. In integrating the differentials from 1872 September 7, backwards, the element of time was regarded as positive, and the sign of the result was changed before applying the correction thus found to the elements, to obtain the effect of the terms depending upon the squares and higher powers of the masses of the disturbing bodies. The perturbation of the mean longitude consists of two parts, one of which is that arising from a change in the mean motion, and depends upon a double integral, and consequently the sign of the result in this case should have been left unchanged. Unfortunately the effect of this error of sign is such that (so far as this element is concerned) the result is less accurate than if the correction had been omitted altogether.

Disturbing Action of Venus.

1888.	ΔL_1 .	ΔL_2 .	$\Delta \pi$.	$\Delta \Omega$.	Δi .	$\Delta \phi$.	$40 \Delta \mu$.
Apr. 16	+ 0 ^{''} 77	+ 0 ^{''} 08	- 3 ^{''} 14	+ 0 ^{''} 15	- 0 ^{''} 10	- 0 ^{''} 31	- 0 ^{''} 176
May 6	0 ^{''} 00	0 ^{''} 00	0 ^{''} 00	0 ^{''} 00	0 ^{''} 00	0 ^{''} 00	0 ^{''} 000
26	- 1 ^{''} 03	+ 0 ^{''} 05	+ 2 ^{''} 40	- 0 ^{''} 06	+ 0 ^{''} 05	- 0 ^{''} 13	+ 0 ^{''} 077
June 15	- 2 ^{''} 06	+ 0 ^{''} 12	+ 3 ^{''} 15	- 0 ^{''} 06	+ 0 ^{''} 05	- 0 ^{''} 63	+ 0 ^{''} 036
July 5	- 2 ^{''} 85	+ 0 ^{''} 08	+ 1 ^{''} 80	- 0 ^{''} 06	- 0 ^{''} 02	- 1 ^{''} 33	- 0 ^{''} 118
25	- 3 ^{''} 17	- 0 ^{''} 15	- 1 ^{''} 48	- 0 ^{''} 12	- 0 ^{''} 12	- 1 ^{''} 99	- 0 ^{''} 355
Aug. 14	- 2 ^{''} 96	- 0 ^{''} 64	- 5 ^{''} 85	- 0 ^{''} 23	- 0 ^{''} 22	- 2 ^{''} 41	- 0 ^{''} 625
Sept. 3	- 2 ^{''} 23	- 1 ^{''} 39	- 10 ^{''} 11	- 0 ^{''} 36	- 0 ^{''} 30	- 2 ^{''} 44	- 0 ^{''} 865
23	- 1 ^{''} 14	- 2 ^{''} 34	- 13 ^{''} 09	- 0 ^{''} 41	- 0 ^{''} 32	- 2 ^{''} 11	- 1 ^{''} 029
Oct. 13	+ 0 ^{''} 06	- 3 ^{''} 41	- 14 ^{''} 04	- 0 ^{''} 34	- 0 ^{''} 30	- 1 ^{''} 56	- 1 ^{''} 083
Nov. 2	+ 1 ^{''} 13	- 4 ^{''} 47	- 12 ^{''} 69	- 0 ^{''} 10	- 0 ^{''} 24	- 0 ^{''} 97	- 1 ^{''} 016
22	+ 1 ^{''} 89	- 5 ^{''} 40	- 9 ^{''} 31	+ 0 ^{''} 26	- 0 ^{''} 16	- 0 ^{''} 55	- 0 ^{''} 833
Dec. 12	+ 2 ^{''} 21	- 6 ^{''} 11	- 4 ^{''} 74	+ 0 ^{''} 64	- 0 ^{''} 10	- 0 ^{''} 41	- 0 ^{''} 569

1889.	ΔL_1 .	ΔL_2 .	$\Delta \pi$.	$\Delta \Omega$.	Δi .	$\Delta \phi$.	40 $\Delta \mu$.
Jan. 1	+2''09	-6''53	-0''19	+0''91	-0''06	-0''61	-0''275
21	+1'56	-6'67	+3'16	+0'95	-0'05	-1'05	-0'016
Feb. 10	+0'77	-6'59	+4'43	+0'71	-0'07	-1'58	+0'150
Mar. 2	-0'11	-6'42	+3'38	+0'23	-0'10	-1'99	+0'178
22	-0'87	-6'29	+0'44	-0'34	-0'13	-2'10	+0'057
Apr. 11	-1'37	-6'34	-3'29	-0'82	-0'14	-1'81	-0'192
May 1	-1'49	-6'69	-6'90	-1'04	-0'15	-1'17	-0'519
21	-1'20	-7'38	-9'04	-0'94	-0'15	-0'32	-0'854
June 10	-0'52	-8'38	-9'22	-0'64	-0'16	+0'51	-1'131
30	+0'48	-9'61	-7'42	-0'25	-0'18	+1'12	-1'301
July 20	+1'68	-10'94	-4'28	+0'10	-0'21	+1'39	-1'348
Aug. 9	+2'81	-12'26	-0'93	+0'34	-0'24	+1'24	-1'268
29	+3'68	-13'44	+1'57	+0'41	-0'25	+0'67	-1'060
Sept. 18	+4'20	-14'35	+2'52	+0'31	-0'22	-0'21	-0'749
Oct. 8	+4'31	-14'93	+1'67	+0'13	-0'17	-1'13	-0'401
28	+4'03	-15'16	-0'66	-0'03	-0'09	-1'86	-0'089
Nov. 17	+3'44	-15'14	-3'64	-0'11	-0'02	-2'25	+0'125
Dec. 7	+2'64	-14'96	-6'16	-0'13	+0'02	-2'22	+0'200

Disturbing Action of the Earth.

1888.	ΔL_1 .	ΔL_2 .	$\Delta \pi$.	$\Delta \Omega$.	Δi .	$\Delta \phi$.	40 $\Delta \mu$.
Feb. 16	-3'36	-0''11	+7'37	-0''23	+0''08	-0''20	+0''176
Mar. 27	-1'82	-0'01	+3'28	-0'03	+0'01	-0'42	+0'034
May 6	0'00	0'00	0'00	0'00	0'00	0'00	0'000
June 15	+1'47	+0'04	-0'83	-0'03	+0'04	+0'79	+0'090
July 25	+2'34	+0'23	+1'40	0'00	+0'12	+1'65	+0'300
Sept. 3	+2'55	+0'67	+5'87	+0'12	+0'21	+2'24	+0'588
Oct. 13	+2'13	+1'41	+10'85	+0'25	+0'26	+2'36	+0'885
Nov. 22	+1'25	+2'41	+14'26	+0'23	+0'26	+2'00	+1'106
1889.							
Jan. 1	+0'17	+3'56	+14'52	-0'04	+0'21	+1'46	+1'177
Feb. 10	-0'81	+4'69	+11'57	-0'50	+0'17	+1'13	+1'061
Mar. 22	-1'36	+5'61	+6'97	-0'91	+0'14	+1'31	+0'783
May 1	-1'44	+6'22	+2'94	-1'04	+0'14	+2'00	+0'417
June 10	-1'01	+6'45	+1'22	-0'89	+0'13	+2'96	+0'056
July 20	-0'09	+6'37	+2'58	-0'63	+0'11	+3'77	-0'205
Aug. 29	+1'41	+6'12	+6'74	-0'52	+0'10	+4'05	-0'290
Oct. 8	+3'61	+5'85	+12'78	-0'58	+0'12	+3'69	-0'227
Nov. 17	+5'84	+5'66	+18'35	-0'61	+0'12	+3'09	-0'171
Dec. 27	+7'33	+5'59	+20'11	-0'60	+0'15	+2'22	+0'024

Disturbing Action of Mars.

	ΔL_1 .	ΔL_2 .	$\Delta \pi$.	$\Delta \Omega$.	Δi .	$\Delta \phi$.	$40 \Delta \mu$.
1888.							
Feb. 16	-0"37	-0"01	+0"69	+0"02	-0"01	-0"08	+0"004
Mar. 27	-0"19	0"00	+0"38	+0"01	0"00	-0"04	+0"005
May 6	0"00	0"00	0"00	0"00	0"00	0"00	0"000
June 15	+0"18	-0"01	-0"36	0"00	0"00	+0"03	-0"010
July 25	+0"31	-0"02	-0"63	0"00	0"00	+0"07	-0"018
Sept. 3	+0"42	-0"04	-0"73	0"00	0"00	+0"12	-0"021
Oct. 13	+0"50	-0"06	-0"68	+0"01	0"00	+0"16	-0"017
Nov. 22	+0"56	-0"07	-0"49	+0"03	+0"01	+0"20	-0"007
1889.							
Jan. 1	+0"60	-0"07	-0"23	+0"05	+0"01	+0"21	+0"007
Feb. 10	+0"62	-0"06	+0"06	+0"06	+0"01	+0"21	+0"025
Mar. 22	+0"63	-0"02	+0"31	+0"07	+0"01	+0"18	+0"043
May 1	+0"63	+0"03	+0"49	+0"07	+0"01	+0"15	+0"061
June 10	+0"62	+0"10	+0"60	+0"05	+0"01	+0"11	+0"077
July 20	+0"61	+0"18	+0"64	+0"04	+0"01	+0"07	+0"092
Aug. 29	+0"60	+0"28	+0"63	+0"02	+0"01	+0"03	+0"106
Oct. 8	+0"59	+0"39	+0"56	+0"01	+0"02	0"00	+0"119
Nov. 17	+0"57	+0"52	+0"45	0"00	+0"02	-0"03	+0"131
Dec. 27	+0"56	+0"66	+0"31	0"00	+0"02	-0"05	+0"142

Disturbing Action of Jupiter.

	ΔL_1 .	ΔL_2 .	$\Delta \pi$.	$\Delta \Omega$.	Δi .	$\Delta \phi$.	$40 \Delta \mu$.
1888.							
Feb. 16	+ 7"42	- 9"79	+ 76"39	- 2"57	+ 1"23	+ 35"52	+ 9"461
Mar. 27	+ 6"24	- 2"52	+ 42"92	- 1"32	+ 0"77	+ 18"63	+ 4"993
May 6	0"00	0"00	0"00	0"00	0"00	0"00	0"000
June 15	- 12"43	- 2"61	- 50"57	+ 0"85	- 1"18	- 19"66	- 5"211
July 25	- 31"70	- 10"34	- 103"80	+ 0"37	- 2"82	- 39"36	- 10"122
Sept. 3	- 57"38	- 22"49	- 150"87	- 2"44	- 4"89	- 58"17	- 14"003
Oct. 13	- 87"36	- 37"68	- 180"57	- 8"43	- 7"20	- 75"28	- 16"034
Nov. 22	- 117"86	- 53"75	- 183"85	- 17"66	- 9"45	- 90"60	- 15"619
1889.							
Jan. 1	- 144"39	- 68"11	- 159"41	- 29"10	- 11"31	- 104"59	- 12"752
Feb. 10	- 163"67	- 78"65	- 115"60	- 40"89	- 12"56	- 117"80	- 8"127
Mar. 22	- 174"66	- 84"11	- 66"10	- 51"16	- 13"18	- 130"19	- 2"861
May 1	- 178"47	- 84"53	- 22"87	- 58"76	- 13"34	- 141"01	+ 1"954
June 10	- 177"32	- 80"66	+ 8"46	- 63"43	- 13"24	- 149"25	+ 5"574
July 20	- 173"53	- 73"79	+ 28"75	- 65"63	- 13"10	- 154"18	+ 7"673
Aug. 29	- 168"95	- 65"82	+ 42"85	- 66"13	- 13"04	- 155"64	+ 8"267
Oct. 8	- 164"90	- 57"78	+ 56"21	- 65"80	- 13"13	- 154"27	+ 7"632
Nov. 17	- 162"18	- 50"84	+ 72"45	- 65"40	- 13"39	- 151"01	+ 6"136
Dec. 27	- 161"20	- 45"68	+ 92"71	- 65"54	- 13"78	- 146"92	+ 4"152

Disturbing Action of Saturn.

1888.	ΔL_1 .	ΔL_2 .	$\Delta \pi$.	$\Delta \Omega$.	Δi .	$\Delta \phi$.	40 $\Delta \mu$.
Feb. 16	-1''00	-0''08	+ 1''29	+ 0''08	- 0''03	- 0''48	- 0''057
Mar. 27	-0'50	-0'01	+ 0'74	+ 0'01	- 0'01	- 0'18	- 0'008
May 6	0'00	0'00	0'00	0'00	0'00	0'00	0'000
June 15	+0'45	-0'01	- 1'00	0'00	- 0'01	+ 0'08	- 0'030
July 25	+0'83	-0'07	- 2'32	0'00	- 0'02	+ 0'09	- 0'094
Sept. 3	+1'09	-0'21	- 3'93	- 0'04	- 0'05	+ 0'05	- 0'185
Oct. 13	+1'23	-0'45	- 5'80	- 0'12	- 0'08	0'00	- 0'295
Nov. 22	+1'24	-0'80	- 7'82	- 0'26	- 0'11	- 0'04	- 0'415
1889.							
Jan. 1	+1'12	-1'28	- 9'86	- 0'45	- 0'15	- 0'07	- 0'535
Feb. 10	+0'88	-1'87	-11'76	- 0'70	- 0'17	- 0'08	- 0'642
Mar. 22	+0'56	-2'55	-13'40	- 0'99	- 0'19	- 0'09	- 0'723
May 1	+0'19	-3'30	-14'70	-1'29	- 0'20	- 0'14	- 0'768
June 10	- 0'20	-4'07	-15'67	-1'57	- 0'19	- 0'24	- 0'766
July 20	- 0'55	-4'81	-16'42	-1'82	- 0'17	- 0'42	- 0'716
Aug. 29	- 0'82	-5'48	-17'11	-2'01	- 0'15	- 0'69	- 0'623
Oct. 8	- 0'97	-6'05	-17'86	-2'13	- 0'12	- 1'00	- 0'505
Nov. 17	- 0'98	-6'49	-18'63	-2'18	- 0'09	- 1'30	- 0'382
Dec. 27	- 0'87	-6'83	-19'26	-2'17	- 0'07	- 1'56	- 0'281

The above values are for Greenwich mean noon.

Reduction of Measures of the Photographs of Jupiter taken at the Lick Observatory in 1890. By A. Stanley Williams.

Through the kindness of Professor E. S. Holden, I have recently been favoured with particulars of an important series of measurements of the belts of *Jupiter*, made by him on the remarkably fine series of photographs of the planet which he obtained last year by means of the great Lick refractor. These measures furnished on reduction the zenographical latitudes of the principal belts; and, as the results are interesting in more ways than one, I herewith beg to present them to the Society.

The photographs measured were enlarged directly in the telescope 8.3 times, the image of the planet on the plates taken at about the time of opposition being very nearly an inch in diameter. The distances were measured by Professor Holden in millimetres from the north pole to the middle points of the chief belts, and the minor axis of the disc was also measured on each plate. In order to show clearly the method of reduction em-